swarms just as some years ago I saw Harma caenis in the Ogové region. They seemed to come from nowhere in particular, they flew in no order, no two even keeping company. Sometimes only a dozen were visible, at other times hundreds seemed to fill the air. They flew a little E. of N. E. This has no particular significance, however, as this is the general direction of the coast here. Even upon the beach the migratory movement was easily observed, and as far as I went back, (about half a mile) the air seemed full of the flies. None were returning, and all flew as if they had a definite purpose in view. A native remarked it, and ventured, in calling my attention to the movement to add 'Sometimes they fly so, and sometimes they fly in the opposite direction.'" . . .

"I am utterly at a loss to account for the phenomenon. The explanation which I suggested for the migration of Harma caenis, which this exactly resembles, will not apply here. That took place near the end of the dry season and was toward the approaching rains. But here the rains are frequent now, and if these flies are seeking anything to northward it must be dry weather."

CHRYSOPSYCHE MIRIFICA Butler.

I have received from Mr. Good several specimens of this exceedingly beautiful bombycid, and also a specimen of the cocoon, which is very tough and dark chocolate brown in color and studded all over as are many of the cocoons of the African Bombycidae with minute spines, which are derived from the epidermis of the caterpillar. The figure upon Plate 5 will serve better than a description to give an idea of the form of the cocoon.

EXPLANATION OF PLATE 5.

Fig. 1. Chrysalis of Saturnia arnobia Westw.
Fig. 2. Chrysalis of Idiomorphus vala Ploetz. (lateral view).
Fig. 3. Chrysalis of Idiomorphus vala Ploetz. (dorsal aspect).
Fig. 4. Larva of Harma caenis Drury.
Fig. 5. Chrysalis of "
Fig. 6. Cocoon of Chrysopsyche mirifica Butler.

CONCERNING THE "BLOOD-TISSUE" OF THE INSECTA.—I.

BY WILLIAM MORTON WHEELER, WORCESTER, MASS.

Hitherto little attention has been devoted to the study of the blood, fat-body, and allied structures in insects. We have extensive monographs on the eyes and other sense-organs, on the musculature and nervous system, and even on the alimentary tract and its various subdivisions, but few serious attempts have been made to fill the gaps in our knowledge of the physiologically highly important tissue, so intimately concerned with the nutrition of the organs. Of these attempts two, however, are worthy of special attention — one by Wielowiejski,[1] who approaches the subject from the anatomical side, and another by Graber,[2] who contributes some valuable observations of an embryological nature.

Wielowiejski includes under the term blutgewebe (blood-tissue) the following structures:

1. The blood corpuscles;
2. the fat-body proper;
3. the pericardial fat-body;
4. the oenocytes, of which he distinguishes three varieties in some insects.

To this list I would add:

5. The garland-shaped cord of Muscid larvae; and
6. a peculiar organ, which I may call the suboesophageal body, and which I have found in the embryos and young larvae of Blatta and Xiphidium.

Wielowiejski is careful not to maintain a common origin for all the components of his "blutgewebe" but comprises them under a common heading on purely physiological grounds, as he expressly states. They are blood-tissue to the extent "dass sie alle von dem sie umgebenden medium gewisse stoffe aufnehmen, zeitweise aufspeichern resp. verarbeiten und irgend welche umsatzprodukte an dasselbe zurückgeben und dadurch auf die in den hauptgeweben des organismus vor sich gehenden assimilations und desassimilationsprocesse einen einfluss ausüben."

Graber is less cautious and does not hesitate to conclude that the different tissues constituting Wielowiejski's blutgewebe are genetically related. Stated very briefly these are the conclusions at which he arrives.

1. The oenocytes are derived from the ectoderm;
2. They are metamorphosed into the fat-body;
3. The blood-corpuscles arise from the fat-body (and also from the oenocytes?).

Ergo the fat-body and the blood are ectodermal structures! Certainly a remarkable conclusion and one which an even more intrepid investigator might hesitate to advance in these days when we are so accustomed to derive the blood-corpuscles and connective tissue from the middle germ-layer. While my own conclusions differ radically from Graber's, so far as the origin of the fat-body is concerned, I cheerfully confess that his interesting paper was the means of calling my attention to this much neglected subject.

Even the earlier entomotomists were familiar with certain huge cells associated with the fat-body. By some they were supposed to assist in respiration since they were often found attached to the fine tracheal ramifications. Graber

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1 Ueber das blutgewebe der insecten. Zeitschr. f. wiss. zool., 43. bd. p. 512-536. 1886.

2 Ueber die embryonale anlage des blut- und fettgewebes der insekten. Biol. centralbl., 11 bd. nos. 7 u. 8. p. 212-224. 1891.

called them[1] "eingesprengte zellen" and regarded them as unicellular glands. It was Wielowiejski who first fully described them and named them oenocytes from their wine-yellow color. He pointed out that these oenocytes are not infrequently the largest cells in the body, excepting the ova, that they are arranged in metameric clusters in the trachigerous abdominal segments and that they are more or less intimately associated with the blood and fat-body. In some cases they occur in the posterior thoracic region. Most frequently pleural in position they may occasionally extend over the sternal region. The separate cells of the clusters are usually distinctly isolated and independent of one another, but in rare instances they may fuse in pairs or to form smaller clusters. The tough and resistent cytoplasmic wall is round or oval and often drawn out into a few pseudopodia-like outgrowths by means of which the cells are suspended to the tracheal ramifications or to one another. The cytoplasm, which is very abundant, is full of yellowish granules and is sometimes radially striated towards its periphery. The large spherical or oval nucleus contains a densely wound and delicate chromatic filament. An idea of the appearance of these cells may be obtained from Fig. 1, which represents a cluster of oenocytes from a nearly mature Phryganeid larva. This specimen does not show the pseudopodia-like outgrowths.

1 Ueber den propulsatorischen apparat der insecten. Archiv f. mikr. anat., 9. bd. p. 129-196. 1873.

To Graber is due the credit of first pointing out the identity of the oenocyte-clusters with certain metameric cell-masses mentioned by embryologists. Tichomiroff[2] and Korotneff[3] described segmental masses of cells originating from the ectoderm near the stigmata and just pleurad to the nerve-cord. Tichomiroff at first regarded these cells as a kind of fat-body but finally concluded that they represented an organ *sui generis* which he called the "gland-like body." Korotneff regarded the migrant ectoderm-cells in Gryllotalpa as mesenchymatous, and if I understand him correctly, as giving rise to the fat-body.

I fully agree with Graber that the embryonic cells described by the two Russian embryologists are identical with the oenocytes of Wielowiejski. Graber is also correct in referring to the same category certain huge cells described by me in Doryphora.[4] They originate from the ectoderm as I have since been able to ascertain.

Graber describes the oenocyte clusters in Stenobothrus as delaminated from the ectoderm. In Hydrophilus he claims that they originate in connection with a distinct pair of metastigmatic invaginations. It appears to have escaped his notice that these invaginations

2 The embryonic development of the silk-worm (Bombyxmori). Publ. labor. zool. mus. Moscow., vol. 1. 1882. (Russian.)

3 Die embryologie der Gryllotalpa. Zeitschr. f. wiss. zool., 41. bd. 1885.

4 The embryology of Blatta germanica and Doryphora decemlineata. Journ. morph., vol. 3, no. 2. p. 291-374. 1889.

were first seen by Patten in Acilius.[1] They are also present, as I have been able to make out, in Blatta, Xiphidium and Dytiscus. With the proper methods Graber would also probably have found them in Stenobothrus. This second pair of segmental invaginations, which Patten took to represent a second pair of tracheal ingrowths, are supposed by Graber to be the formative centers of the oenocyte clusters. He admits, however, that a delamination of the area surrounding each pit contributes largely to their formation. My own observations lead me to believe that the invaginations are very weak and transient and that they contribute very few, if any elements to the clusters; most of the oenocytes originating by delamination and immigration from a considerable area just caudad to the stigmata. In Lepidoptera this area is more extensive than it is in the Orthoptera.

In nearly mature Xiphidium embryos the oenocyte clusters may be seen shining through the hypodermis much as I have represented them in Fig. 2. They form eight bands running along the pleural wall just back of and alternating with the stigmata.

Now Graber maintains that the fat-body, at least in part, arises from these oenocyte clusters. But a section through a young Blatta embryo (Fig. 3) shows most conclusively that this is not the case. At *o* may be seen the oenocytes, still forming a part of the ectoderm *v* from which they have differentiated, while the fat-body *e* is simply a thickened portion of the inner coelomic wall. The thickening is largely due to an accumulation of fat-vacuoles in the cytoplasm of the mesoderm-cells. Were Graber correct in his assumption we ought either to find no adipose tissue in the embryo outside of the eight trachigerous abdominal segments or be able to show that the oenocytes migrate into the head, thorax and terminal abdominal segments and there form the fat-body — since fat-tissue is developed in all these regions of the body. But although some of the oenocytes do later on migrate into the metathorax and perhaps even into the mesothorax, they never occur in the head. Moreover, long before any migration takes place, thickenings of the coelomic wall, similar to that in the figure, are found giving rise to the fat-body in the thorax, gnathitic segments and also in the terminal segments of the abdomen. Furthermore, the oenocytes, so far as I have been able to observe, are always perfectly distinct from the fat-body, never contain fat-vacuoles, and never divide after they are once differentiated from the ectoderm during embryonic life. Their number is therefore subject to no increase during the growth of the animal. They are, as Tichomiroff claimed, a series of organs *sui generis*. Although they certainly resemble the blood-corpuscles in some insects, they are always much larger and seem not to be amoeboid. They are never seen constricting, or exhibiting any appearance of giving rise to the blood-cells. It follows then

1 On the origin of Vertebrates from Arachnids. Quart. journ. micr. sci., vol. 31, pt. iii, new ser. p. 317-378. 1890.

that the fat-body is not derived from the oenocytes, that it is not of ectodermal but of mesodermal origin as claimed by the majority of authors, and that there is no evidence for the origin of the blood from the oenocytes.

It is interesting to note that only the winged orders of Hexapoda, the Pterygota, seem to possess oenocytes. I could find no traces of these peculiar cells in *Lepisma saccharina*, *Campodea fragilis* (young and adult) and *Anurida maritima*, insects which may be taken to represent the three families of the Apterygota. If oenocytes exist at all in this subdivision of the Hexapoda, they are probably confined to the embryo or to the forms most closely allied to the Orthoptera — like Machilis.

I believe that oenocytes do not occur in the Myriopoda. In the just-born young of *Scolopendra complanata* from the Galapagos I find no traces of them and so far as I am aware they have not been described by any of the investigators of Myriopod anatomy.

DESCRIPTION OF A SARCOPHAGA BRED FROM HELIX.

BY C. H. TYLER TOWNSEND, LAS CRUCES, N. MEX.

I have recently received from Mr. H. A. Surface, of the Ohio experiment station, a small Sarcophagid which he bred from *Helix thyroides* Say, while engaged on his catalogue of shells of Franklin County, published in Bulletin 2, volume 1, technical series, of that station.

Mr. Surface accompanies the specimen with the following note: "The snail was placed in a tight bottle August 25, in Warren County, Ohio, and during the first part of September the pupae were seen. From September 27 to 30 five or six mature flies came forth."

The fly proves to be a small species of Sarcophaga. After considerable time spent in looking over descriptions of North American species, I feel justified in considering it new.

Sarcophaga helicis n. sp. ♀.

Eyes brown, bare; front, sides of face and cheeks silvery or cinereous, sometimes with a brassy reflection; frontal vitta dark brown or blackish, about one-third width of front, the front being about one-third width of head; frontal bristles descending a little below base of antennae; the two vertical bristles strongest, directed backward, next three bristles also directed backward, rest more or less forward; two orbital bristles directed forward; a strong anterior pair of ocellar bristles directed forward and outward; sides of face with a few bristles in a row on lower portion next orbital margin; cheeks about one-fourth eye-height, sparsely hairy with a row of bristles on lower border; facial depression more or less silvery, epistoma rather prominent; facial ridges bare except two or three bristly hairs next vibrissae, the latter decussate and inserted on the oral margin; antennae a little shorter than face, black, second joint slightly elongate with a long bristle on front border, third joint